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SCADA System for Solar MPPT Controller Monitoring

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Abstract

The present paper deals with the simulation of a solar photovoltaic MPPT controller used for the supply of a power consumer. The power system contains a photovoltaic generator, MPPT controllers, batteries, power consumers and the connection to a local grid. The solar photovoltaic MPPT controller is implemented by using the "perturb and observe" (P&O) algorithm that varies the PV generator voltage and returns the peak power that can be supply the power consumer. The solar radiation intensity, the power load curve and batteries behavior will also be studied correlated with the solar photovoltaic MPPT controller. The developed application based on the proposed algorithm provides the parameters of the power system components and the power flow. The developed application in CitectSCADA environment simulates the MPPT regulator behavior based on mathematical functions entries for the load curve and for the solar radiation on a given location. The developed application highlights the electrical parameters of all the system components, resulting in an efficient MPPT controller integrated into a solar PV system.

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Keywords: renewable energy; solar power system; MPPT controller.

1. Introduction

The generated voltage and current from a photovoltaic panel depends on the manufactured material and size of photovoltaic cells. The power variation curve is determined as the product of voltage and current, by considering the values of the current-voltage characteristic curve. The maximum power is achieved at a point after the electric current has begun to drop down. This point on the curve is called the maximum power point (MPP). The power thus

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obtained at this point is called the point of maximum power output (P_{PV}). Fig.1 illustrates the current-voltage and power voltage characteristics for photovoltaic panel with a power of maximum 240 W.

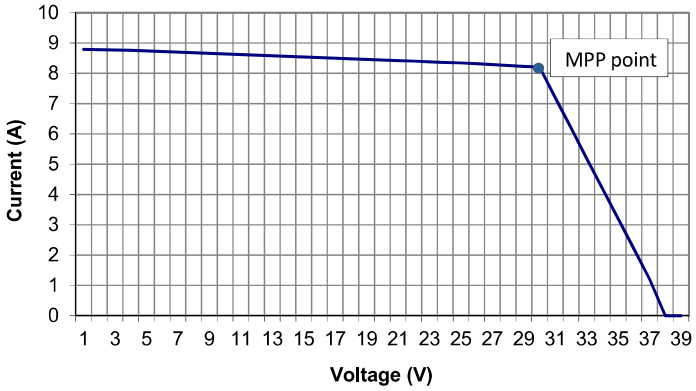

Fig. 1. Current-voltage and power voltage characteristics for photovoltaic panel with a power of maximum 240 W.

The coordinates of the MPP are voltage at the maximum power (V_{mpp}) and current at full power (I_{MPP}) .Other important factors of photovoltaic cells are short-circuit current (I_{SCC}) and idle voltage (V_{oc}) (Fig. 2).

The photovoltaic panel generated current is proportional to illumination (luminous incident flux) at the panel surface. A solar cell generated current is also proportional to S junction area that is exposed to direct solar radiation. In order to increase the illumination of a PV panel, it is desirable that the panel orientation to be such that solar radiation fall perpendicularly on it to the duration of illumination. That condition occurs in necessity of PV solar panel to operate at the point of maximum power at different levels of solar radiation.

Nomenclature

MPPT	Maximum Power Point Tracker
SCADA	Supervisory Control and Data Aquisition
PV	Photovoltaic
MPP	Maximum Power Point
P&O	Perturb and Observe
GUI	Graphical User Interface

2. MPPT tracking algorithms

Specialized literature [1,2,3] includes several algorithms for MPP tracking and the most used being P&O (Perturb and Observe) algorithm, Open and short circuit method and the Incremental Conductance algorithm. Although, these methods are widely used, they have the disadvantage of a slow response to rapid solar radiation variations, oscillations around the MPP or even tracking the Sun in the wrong direction.

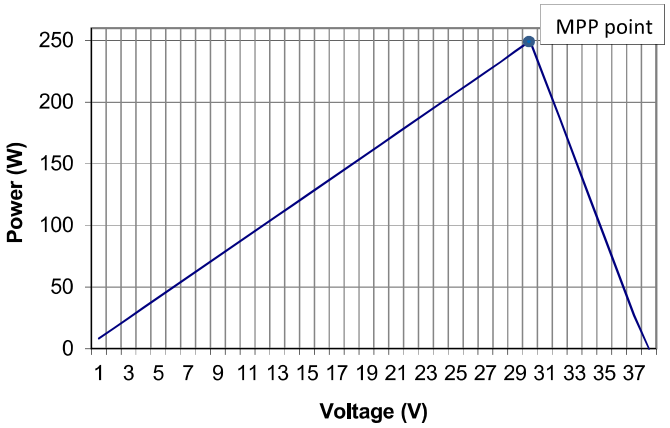

Fig. 2. Maximum power point coordinates

P&O algorithm is very simple and easy to implement and consist in finding the MPP through repeated trials (ie.: by modifying the voltage at the generator terminals and comparing the electric power supplied in this case with the electric power provide at the previous step) [4]. If the electric power of the current step has a higher value than the one from the previous step the voltage will be modified in the same direction, if not the modification will be in the opposite direction. This way to find the MPP leads to oscillations around the MPP, even in stationary operation conditions [6]. Unfortunately, the sudden variations of solar radiation could even lead to malfunctioning by tracking the Sun in the wrong direction. (Fig.3).

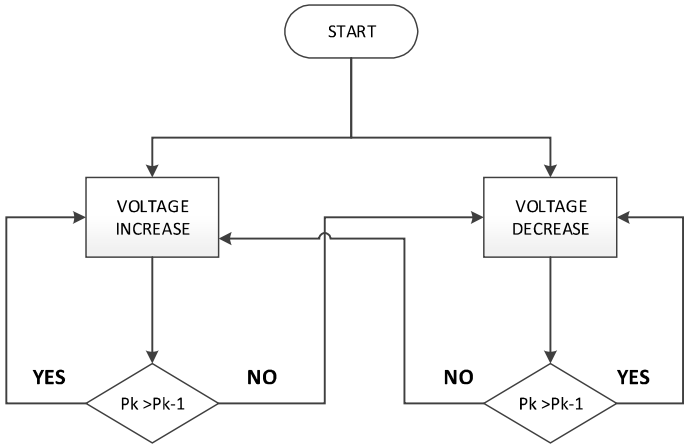

Fig. 3. P&O algorithm principles[7]

3. CitectScada application for MPPT controller monitoring

The CitectScada [5] developed application simulates and monitors a MPPT controller used in a household application with a modeled consumer (2400 W supplied form solar PV panels, connection with the local grid and an 840Ah storage capacity). The diagram of the proposed application is presented in Fig. 4.

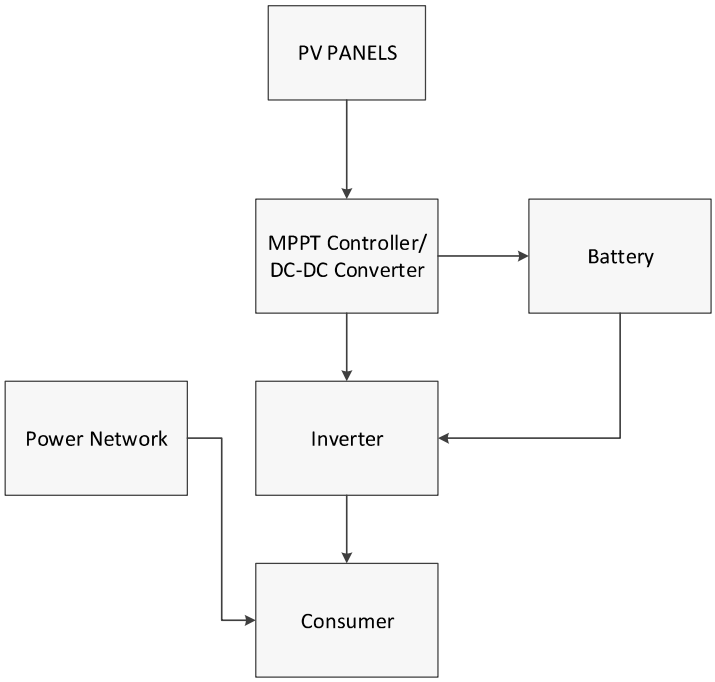

Fig. 4. Diagram of the proposed application

The application GUI contains graphical elements such as: solar PV generator, MPPT controller, storage battery, inverter, domestic consumer, local grid, consumer load curve display and solar radiation display as shown in Fig. 5.

The application provides online data regarding the solar PV generator with and without an MPPT regulator highlighting the efficiency of such an implemented device in solar PV systems.

Solar PV generator consists of 16 monocrystalline panels with an installed power of 3200 W used to charge the batteries in order to ensure the energy demand of the considered consumer. The generated power is influenced by daily solar radiation; for example at 14 o'clock the solar radiation is around 980W/m^2 and the PV generated power exceeds 2800W. The simulation starts at midnight when the PV panels do not produce electricity and the consumer is supplied from the batteries.

The consumption has a low value during the night and therefore the batteries are designed to supply the consumers until the morning, when the consumption suddenly increases and the batteries are depleted. From this moment the consumer is supplied from the local power grid because the solar radiation has a lower value (around 43 W/m^2) and the PV generator can't assure the needed amount of electricity.

After a few hours (9-10 o'clock a.m.) the solar radiation increases to values above 300 W / m^2 and the PV generator will produce enough power for charging the battery and assure the consumer demand (the consumption decreases after the morning peak load). At this point the effectiveness of MPPT regulator can be observed, because this device measures the instantaneous voltage and current generated by the solar PV panels and by using the described algorithm (P&O) and modifies the voltage values in an ascending or descending way and delivers the maximum possible generated power.

4. Conclusions

The paper presents of a solar photovoltaic MPPT controller used for the supply of a power consumer. The solar photovoltaic MPPT controller is implemented by using the "perturb and observe" (P&O) algorithm and studied in correlation with the solar radiation intensity, the power load curve and batteries behavior.

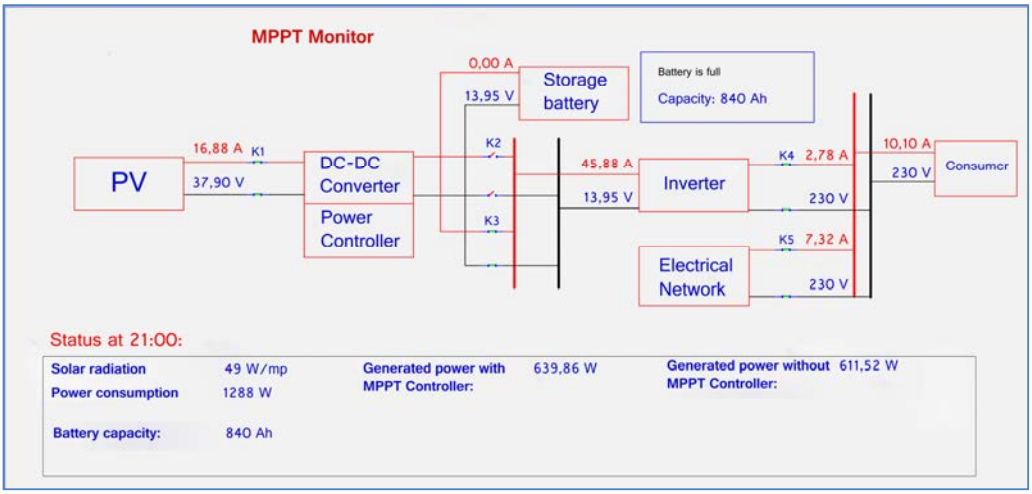

Fig. 5. CitectScada application for MPPT controller monitoring – user window.

The developed application in CitectSCADA environment simulates the MPPT regulator behavior based on mathematical functions entries for the load curve and for the solar radiation on a given location. The behavior and efficiency of an MPPT regulator were also analyzed and the conclusion was that a MPPT controller connected to a photovoltaic system is saving about 20% of energy consumption.

For the proposed application it can also be observed that a photovoltaic system installed on a small consumer is efficient if the system is connected on the local power system. Another important conclusion was that the MPPT controller is essential on battery charging.

Acknowledgements

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